Hydraulic Fracturing and Shale Gas Production: Technology, Impacts, and Policy

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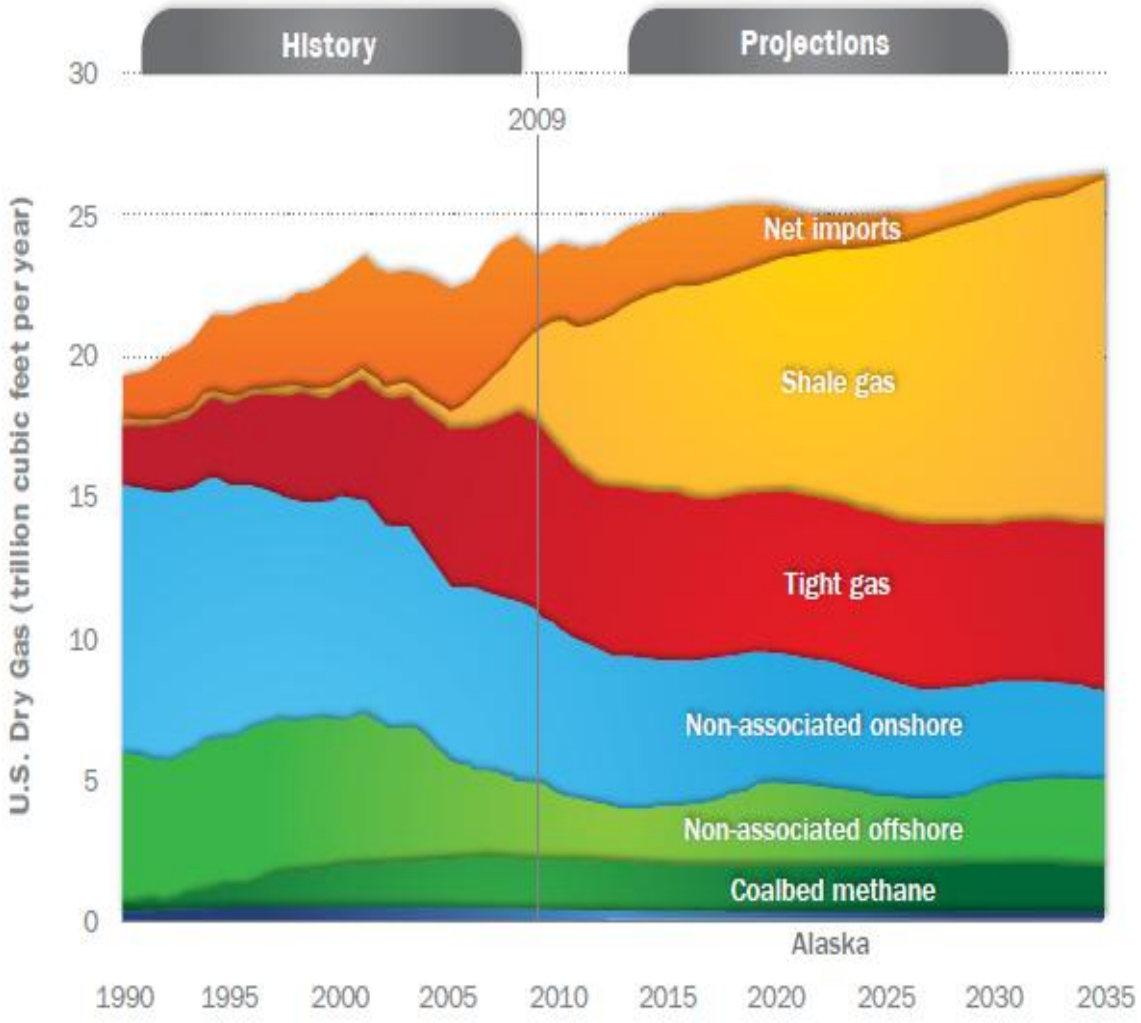
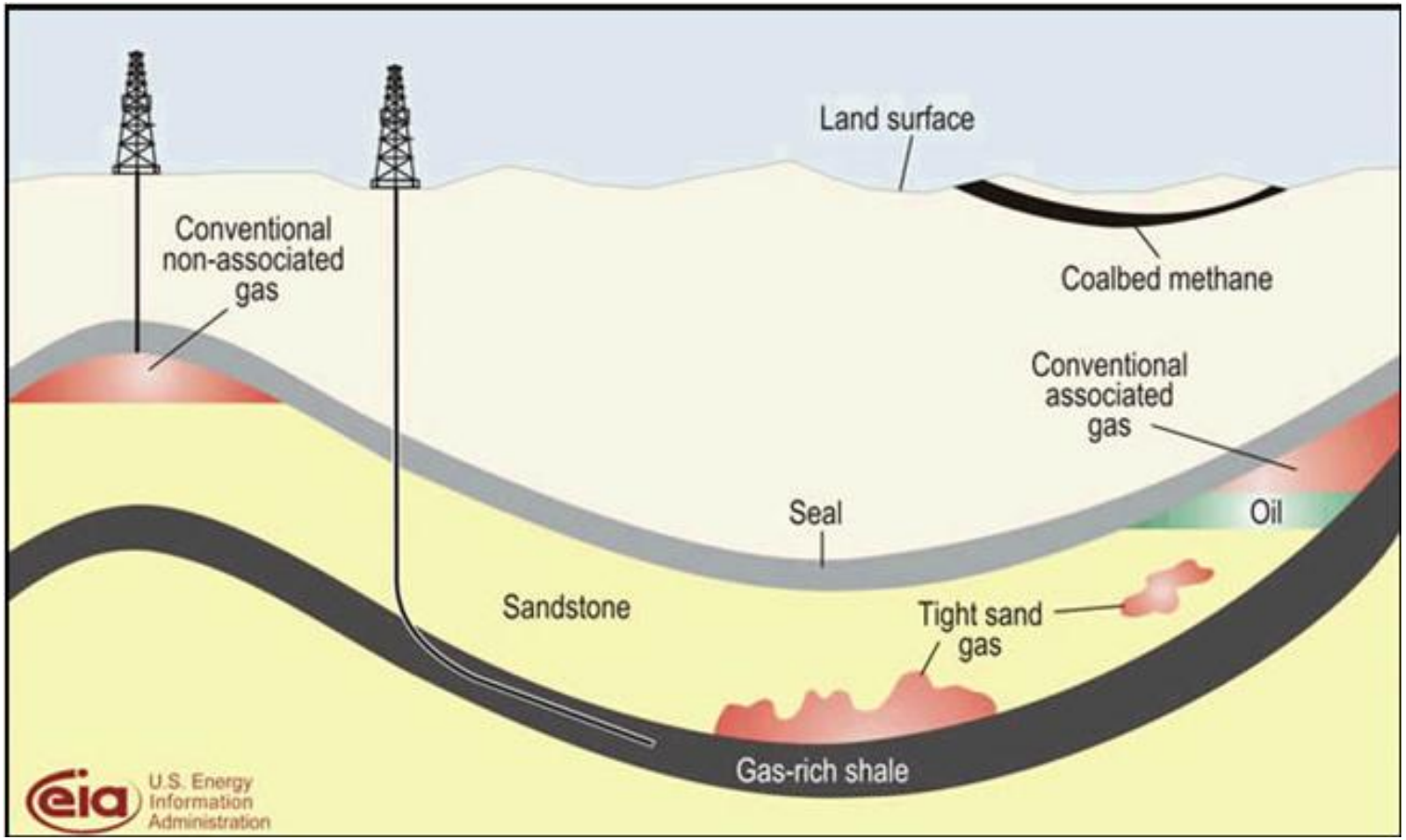
Shale Gas Described as a "Game Changer"

- Projected to account for ~50% of U.S. production in 2035
- Created interest in expanding NG use in several sectors
- But what are the environmental impacts?



Source: EIA - Annual Energy Outlook 2011

How is Shale Gas Different than Other Types of Gas Production?

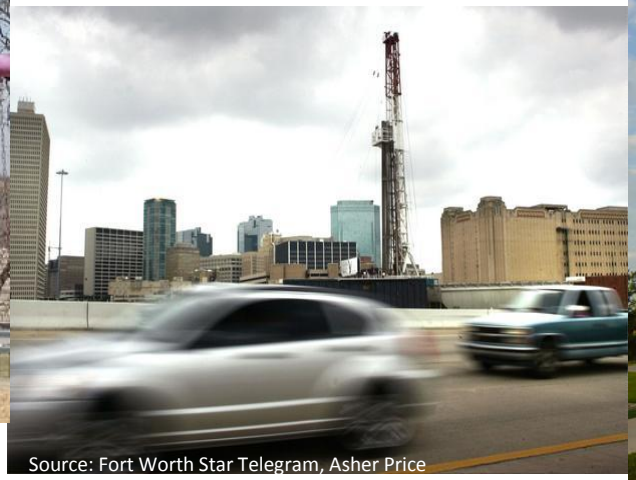


- Economic production has been made possible due to
  - Horizontal drilling
  - Hydraulic fracturing (aka “fracking”)

Several Plays in Areas Without Recent Gas Production Experience

Production Near Residential & Urban Areas Has Increased Scrutiny


Source: TexasSharon.com


Source: Fort Worth Star Telegram, Asher Price


Source: Earth Island Journal, Jason Mark

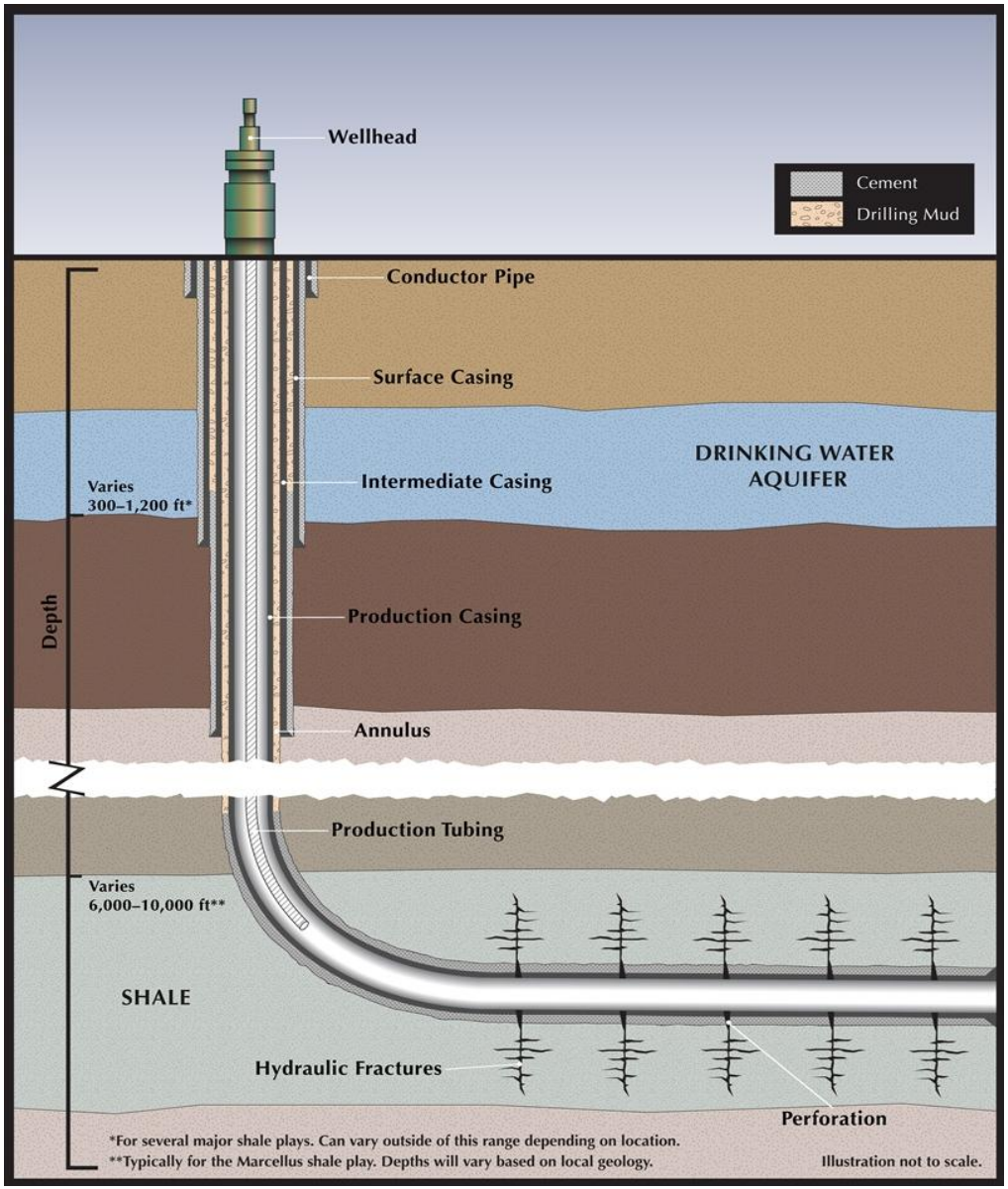

Source: Andy Burnham


Source: Andy Burnham


Source: Pittsburgh Post-Gazette, Darrell Sapp

Fracking is Misused as Umbrella Term for Shale Gas Production

- Fracking is one of many steps in shale gas development
  - **Many of the risks are not from fracking**
- Production steps include:
  - Road/well pad construction
  - Drilling
  - Casing
  - Hydraulic fracturing
  - Water management
  - Gas production
  - Well abandonment & reclamation



Potential Environmental Impacts from Shale Gas Development

- Water Consumption
- Water Quality
- Greenhouse Gas Emissions
- Local Air Pollution
- Earthquakes
- Community Impacts

Source: Andy Burnham

Source: Chris Harto

Water Consumption – Impacts and Mitigation

- 2-6 million gallons of water required to frack a shale gas well
- Consumption is small compared to other uses
  - <1% of total use in a water basin
- Withdrawal may still strain communities due to local conditions, competing demands, etc.
- Increasingly operators are recycling "flowback" water
  - Reduces fresh water consumption & wastewater disposal

Source: Chris Harto

Source: Chris Harto

Water Quality - Impacts

- **No known** incidents of frack chemicals migrating into **underground drinking water**
  - Possible case in WY but results of EPA study controversial
- **Multiple** incidents involving **surface water contamination** from spills
  - Water management is necessary
- **Multiple** events of **natural gas migration** into groundwater due to **poor well construction**
  - Not due to hydraulic fracturing
  - Casing/cementing are key to limiting impacts

Source: Andy Burnham

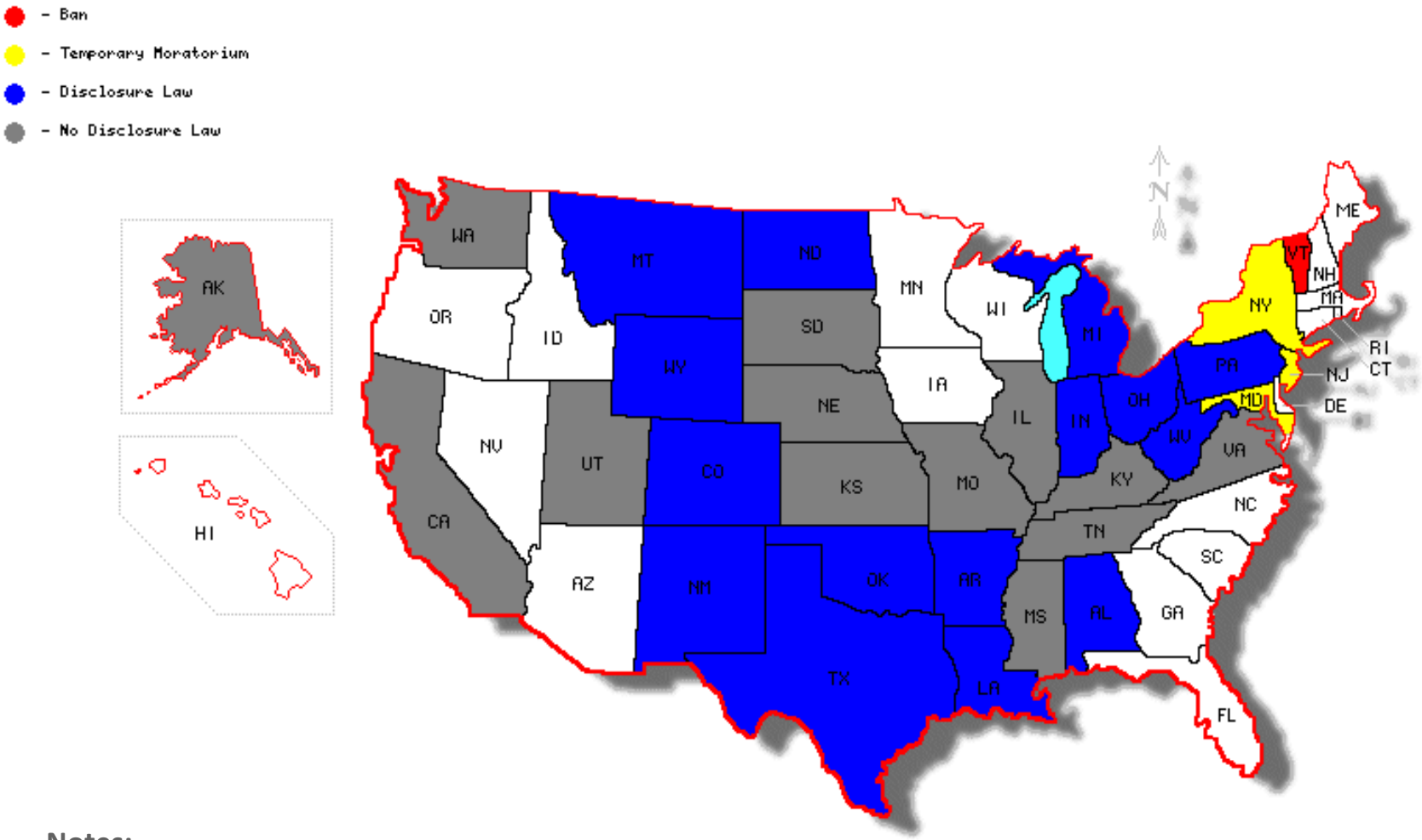
Water Quality – Regulation and Mitigation

- **EPA** authority on **underground injection** limited under Safe Drinking Water Act
  - EPA regulates **surface water disposal** & has imposed penalties
- **Bureau of Land Management** draft rules for development on public lands include:
  - **Disclosure** of frack fluid composition
  - **Wellbore integrity** (well construction requirements)
- **Water regulation occurs** primarily at the **state level**
  - Typically focus on **disclosure**
  - Can also include **disposal** methods
    - PA effectively outlawed discharging to surface water
  - Some regulate **wellbore integrity**

Source: Chris Harto

Source: Chris Harto

State Regulations: Disclosure Laws and Bans



Notes:

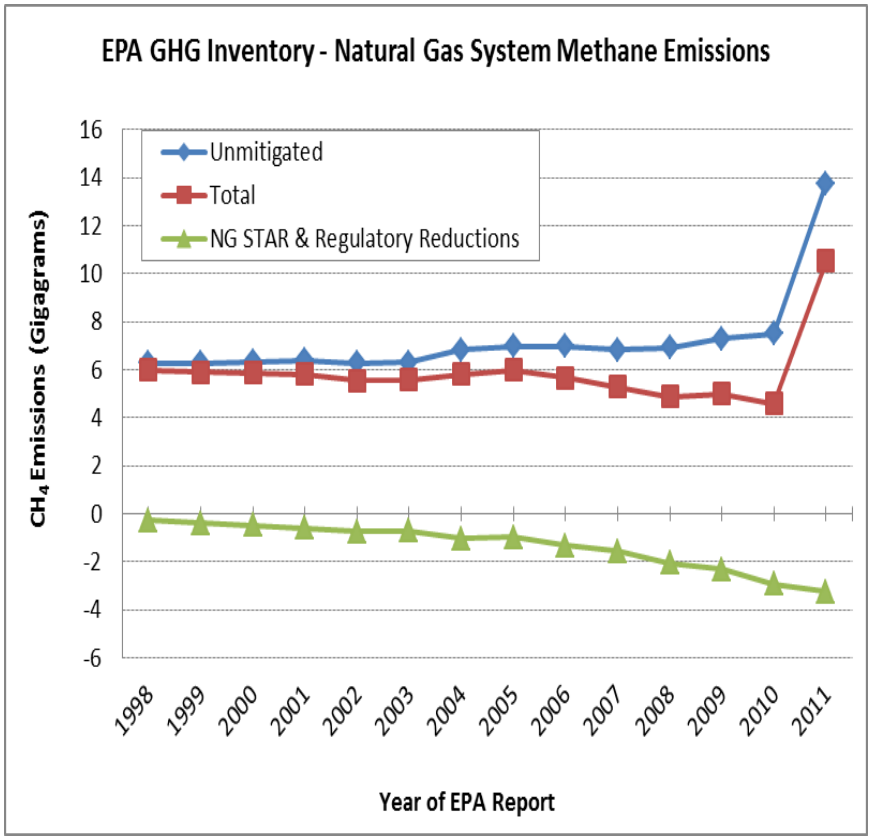
White states have no disclosure law and no current hydraulic fracturing activity

Grey states have no disclosure law and some hydraulic fracturing activity

Source: McFeeley, 2012; Courtesy diymaps.net

Greenhouse Gas Emissions: Impacts

- EPA estimates of **CH_4 leakage** from natural gas have **increased significantly**
- Shale gas well leakage large in theory
  - But industry reports that a **significant amount is captured**
  - Data is limited & lack of transparency
- Using latest estimates of leakage, shale gas provides:
  - **Large GHG benefit** for **NG power plants** as compared to coal
  - **Small GHG benefit** for **NG cars & trucks** as compared to gasoline/diesel



Local Air Pollution and GHG – Impacts and Mitigation

- Some state inventories show **oil & gas operations** as **major sources of local air pollution**

- **Limited analysis** done on **health impacts** of shale gas production
  - Texas is working on a Barnett Shale inventory
  - VOCs and hazardous air pollutants (HAPs) can escape during flowback & NGL storage tanks
  - NO_x produced from engines powering on-site equip.

Source: marcellus-shale.us

- 2012 EPA rules expected to **reduce VOCs at shale gas wells by ~90%**
  - **Reduce NG industry VOCs, HAPs, and CH_4 by ~10%**
  - Requires flaring or reduced emission completions
  - Many technologies reduce gas leakage & emissions

Source: marcellus-shale.us

Earthquakes – Impacts and Mitigation

- Injection of flowback water into disposal wells linked to minor earthquakes in Arkansas & Ohio
  - Not due to fracking
- Recent National Research Council study concludes fracking does not pose major risk for producing earthquakes
- Properly sited injection wells will not cause earthquakes
  - Majority of disposal wells do not pose a hazard

Source: Chris Harto

Source: Chris Harto

Community – Impacts and Mitigation

- Shale gas production is an industrial process
  - Concerns amplified when near residential & urban areas
  - Many issues only last during drilling & fracking (~6 months)
- Potential impacts include:
  - Noise pollution
  - Light pollution
  - Increased traffic/road degradation
- Industry must engage communities & improve on best practices
  - Using sound barriers
  - Limiting hours of operation

Source: Andy Burnham

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Summary

- Shale gas represents a large potential resource for domestic natural gas
- However it must be produced in a manner that protects both the environment and human health
- Shale gas production is an industrial process and there are associated risks
- While all risks are not fully understood, analysis to date shows they are manageable
  - Most incidents were preventable
  - Many risks are inherent to oil & gas production and not related to fracking
  - Regulation and technology development are addressing many of the issues

Thank you!!!

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